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## A SKULL WITH JAWS OF *CROCODILUS SIVALENSIS* LYDEKKER

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### INTRODUCTION

In the series of fossil vertebrates collected by Mr. Barnum Brown in India is a well-preserved skull of a short-snouted crocodile, with jaws, from the Upper Siwalik Beds, fifteen miles east of Chandigarh, India. Examination of the characters of this skull reveals considerable similarity to *Crocodylus palustris* Lesson, to *C. sivalensis* Lydekker, and to *C. palaeindicus* Falconer and Cautley.

Certain critical anatomical structures that serve to distinguish these three closely related species from each other are lacking in the present specimen, but enough structures are preserved to indicate its reference to *C. palaeindicus*, at least provisionally.

The specimen is sufficiently well preserved to deserve description.

**SPECIMEN.**—Amer. Mus. Nat. Hist. No. 1915. Skull with outline essentially complete, some local portions missing. Jaws practically complete. A few teeth in position in both skull and jaws.

**TYPE LOCALITY AND LEVEL.**—About fifteen miles east of Chandigarh, India. In variegated beds of the Upper Siwalik Formation, immediately below the Boulder Conglomerate.

### GENERAL FORM OF SKULL

The skull is broad and short. The breadth of the snout at its base is about three-fourths of its length. The anterior portion of the snout, surrounding the external narial aperture, is particularly broad. The length of the snout from the lateral notches at the premaxillo-maxillary sutures to the tip, is about five-ninths of the breadth of the snout at the expansion immediately anterior to these notches. The notches themselves are sharp and clean-cut but do not extend very far inward from the normal lateral margins.

Posterior to the notches the borders expand to the level of the fifth maxillary teeth, then contract to the level of the eighth maxillary teeth, then expand gradually and more or less regularly to the region of the quadratojugals.

<sup>1</sup>Contributions to the Osteology, Affinities, and Distribution of the Crocodilia. No. 25.

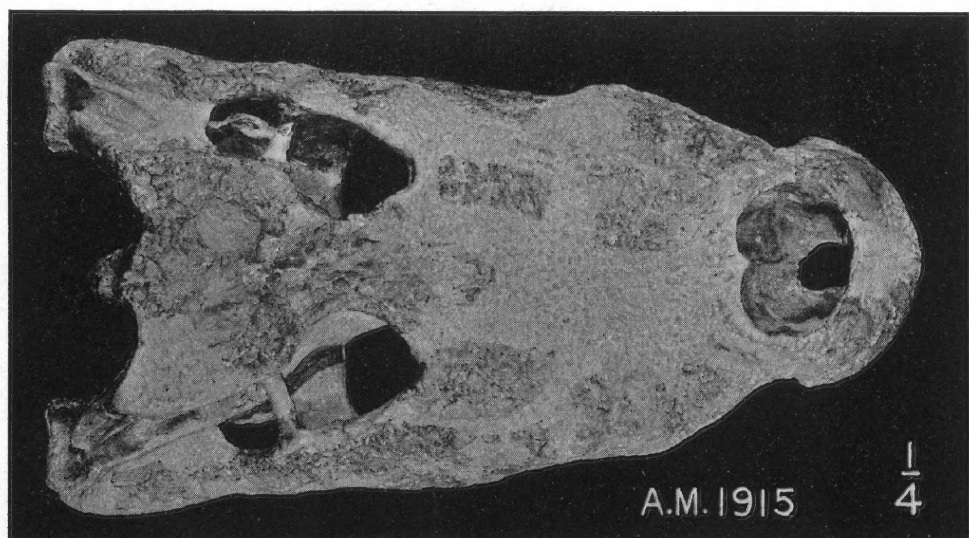


Fig. 1. *Crocodilus sivalensis* Lydekker. Skull. Amer. Mus. No. 1915. About one-fourth natural size. Superior view.

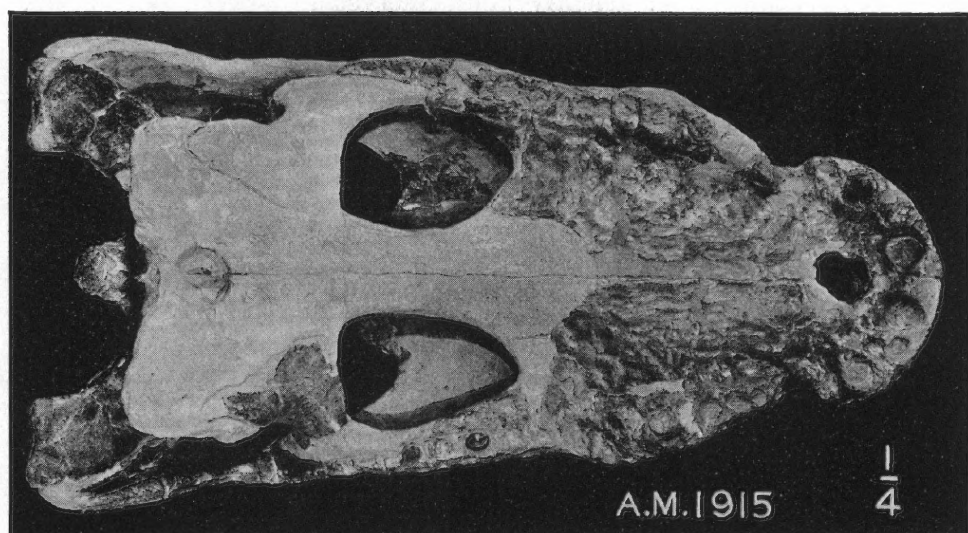


Fig. 2. *Crocodilus sivalensis* Lydekker. Skull. Amer. Mus. No. 1915. About one-fourth natural size. Inferior view.

Viewed from the side the upper profile appears to be slightly convex, but this region is not completely preserved. The lower profile exhibits a pronounced degree of festooning. Starting at the tip, the border descends slightly, in a straight line, to a point half-way between the anterior and posterior borders of the narial aperture, then bends sharply upward to form the anterior border of the premaxillary notch. From the junction of the premaxillo-maxillary suture and the external border, the inferior border bends sharply downward and backward to the level of the fifth maxillary teeth. The notch is much more pronounced in the lateral than in the superior view. From the fifth maxillary tooth the inferior border bends sharply upward and backward to the level of the eighth maxillary tooth, then backward and downward to the level of the tenth maxillary tooth, then backward and slightly upward to the level of the lateral temporal fenestra, then downward and backward to the posterior border of the quadrates.

The cranial table is relatively long in proportion to its breadth. Its lateral borders appear to converge rather gently forward. The posterior border of the table is extremely irregular, projecting backward at the postero-external angles and at the mid-line, and curving forward immediately behind the supratemporal fenestrae. The spaces between the supratemporal fenestrae and the posterior border are broad. The interfenestral plate is narrow, but the interorbital plate is of moderate width.

#### THE CAVITIES OF THE SKULL

The SUPRATEMPORAL FENESTRAE are small and are close together. They are ovoid in form, the broader portion being posterior to the narrow portion. The maximum breadth is about two-thirds of the length. The axes of maximum length converge slightly forward.

Each fenestra is farther from the external border than it is from the other fenestra, but is nearer the external border than the posterior border.

The LATERAL TEMPORAL FENESTRAE have imperfectly preserved borders on each side, so their outline cannot be positively determined. They do not appear to be particularly distinctive.

The ORBITS are large and subcircular in outline, their breadth being approximately equal to their length. They face upward and slightly outward, as in most crocodilians, but the lateral component is somewhat greater than is usual in true crocodiles. The latter character does not appear to be accentuated by crushing. They extend forward about to the level of the twelfth maxillary teeth.

The external narial aperture is very distinctive. Its borders are not complete, but enough of them are present to enable the form and size of the aperture to be made out with a fair degree of accuracy. The size

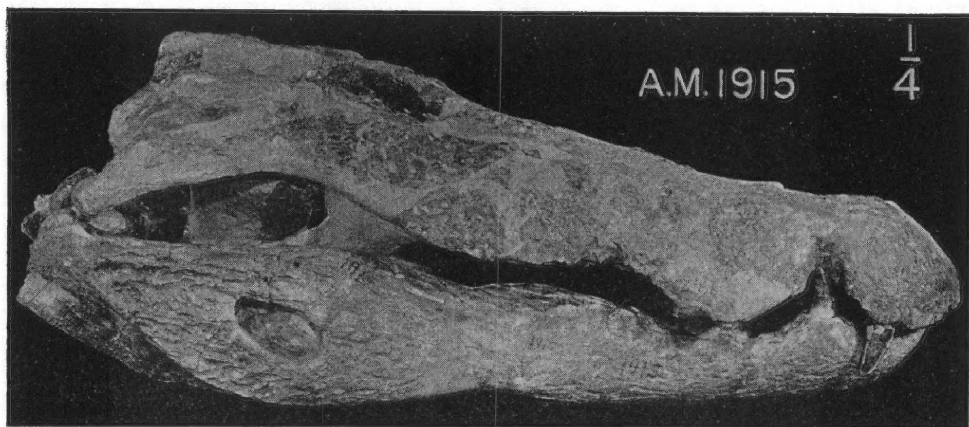


Fig. 3. *Crocodilus sivalensis* Lydekker. Skull and Jaws. Amer. Mus. No. 1915. About one-fourth natural size. Lateral view, right side.

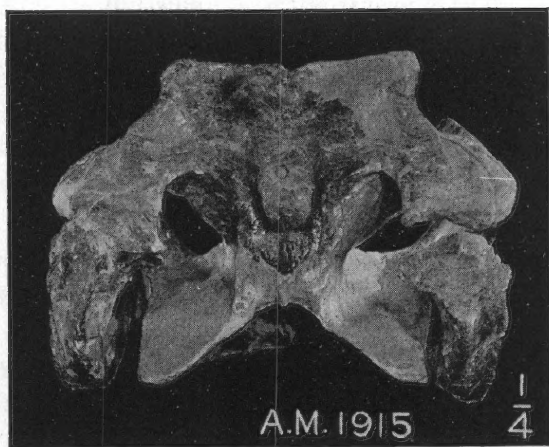


Fig. 4. *Crocodilus sivalensis* Lydekker. Skull. Amer. Mus. No. 1915. About one-fourth natural size. Posterior view.

of the aperture is enormous. It is relatively far larger than in any known crocodilians except the three Indian species—*C. palustris*, *C. sivalensis*, and *C. palaeindicus*. Its breadth is about five-sixths of its length. Its breadth is also about two-thirds of the breadth of the snout across the

notches. The aperture is quite far back in position; about three-fifths of its length is anterior to the level of the notches and about two-fifths is posterior to this level. The space between the aperture and the anterior end of the snout is about three-fifths as long, measured along the mid-line, as the antero-posterior diameter of the aperture.

The PREMAXILLARY FORAMEN, on the palate, has the borders incompletely preserved, but enough of them is preserved to indicate the character of the opening. It is oval in outline, its antero-posterior diameter being slightly greater than its transverse one. The level of the posterior border of the foramen coincides with the level of the posterior edges of the fifth premaxillary teeth.

The PALATINE FENESTRAE have very incomplete borders. The internal borders are lacking on both sides. The external borders are partially preserved on each side. The anterior border of the left fenestra is preserved, also most of the posterior border of the right one. The characters of the fenestrae can be determined with a fair degree of accuracy. They are somewhat broader in proportion to their length than in most species, the breadth being about two-thirds of the length. The anterior tips of these fenestrae are at the level of the anterior ends of the tenth maxillary teeth.

The region of the INTERNAL NARIAL APERTURE is not preserved.

#### THE BONES OF THE SKULL

Some of the bones of the skull are missing; others are incomplete, or their sutural boundaries are obscure. Other bones are well preserved, have clearly outlined boundaries, and are distinctive in form. These are described in some detail.

THE PREMAXILLARIES.—The premaxillary region is especially characteristic, being very broad and short. The sutures on the superior surface are obscure, but it appears unlikely that the posterior processes extended very far back. The region anterior to the narial aperture is unusually large.

On the palate, boundaries can be determined more accurately. The maximum length is about three-fourths the maximum breadth. The alveoli are well-preserved except the first and the second. The characters of the teeth may be judged from the alveoli to a certain extent. The first premaxillary teeth, as determined from the right alveolus, were very small; they were situated close to the mid-line and very close to the anterior border. They bit between and anterior to the first mandibular teeth. The second alveolus is preserved on the right side only.

It is very small and is rather obscure. It is separated widely from the first alveolus, but is very close to the third one. The third alveolus is complete on both sides, and on the right side contains a broken tooth. This alveolus is much larger than either the first or the second. Its external border is in line with the first and second, but its internal border extends considerably farther inward and is supported by a strong buttress. It is very close to the second and is moderately far from the fourth. The fourth alveolus is complete on both sides, the right one containing a broken tooth. It is by far the largest in the premaxillary series, equaling in size the fifth maxillary. The tooth has about twice the diameter of the third and four or five times that of the second. It is equally spaced from the third and fifth. Its internal border extends much farther inward than any of the other premaxillary teeth and is supported by a very stout buttress. The fifth alveoli are complete on both sides. They are of moderate size, being slightly smaller than the third and much larger than the first or second. They are rather close to the fourth, but do not have strong buttresses as do the latter.

Partly posterior to the first alveoli and partly posterior to the spaces between the first and second alveoli are two large pits that received the first lower teeth. These pits are broad and deep, but they do not penetrate to the superior surface of the skull. A pair of smaller pits is situated between and slightly internal to the third and fourth teeth. These pits are bounded anteriorly and posteriorly by the buttresses that support the third and fourth teeth. The pits extend little, if at all, below the level of the palatal surface of the skull. The order in size of the premaxillary teeth, from the smallest to the largest, is: 2d, 1st, 5th, 3d, 4th. The premaxillo-maxillary suture, on the palate, extends directly inward, on each side, from the notch for about one-third of the distance from the tooth-row to the midline, then bends backward and inward for a similar distance, then extends almost directly transverse for a slightly shorter distance, then inward and forward to the mid-line. The posterior point in the suture is at the level of the second maxillary teeth.

The MAXILLARIES are broad on the superior surface of the skull; they are characterized by rough pitting, and by nodose elevations. The sutural boundaries are for the most part not very clear, except to indicate that these bones extended back to a level slightly anterior to the centers of the orbits.

The palatal portions of the maxillaries are well preserved. The suture along the mid-line is unusually short, being only seventeen per cent. of the length of the skull from condyle to tip of snout. In most

crocodilians, even the short-snouted species, this percentage is over twenty-five. The posterior end of the maxillaries, along the mid-line, is at the level of the seventh maxillary teeth.

Each maxillary contained fourteen teeth. Only one of these, the tenth of the right side, is completely preserved. It is comparatively short-crowned and long-rooted; its antero-posterior diameter is considerably greater than its transverse, and the rounded apex of the crown is nearer the internal than the external margin. No blade appears anywhere on the tooth, its sides being rounded in every direction. Other teeth that are partly preserved give evidence of a short, stout type of dentition. The first six teeth on each side are lodged in a strong ridge, which extends far below the level of the palatal surface, especially in the vicinity of the fourth and fifth teeth. This character may have been accentuated somewhat by crushing.

The first maxillary teeth are small; from the first the teeth increase regularly in size back to the fifth, which is the largest in the series. The sixth approximately equaled the fourth in size. Posterior to the sixth the teeth were all of moderate size, the thirteenth and fourteenth being somewhat smaller than the rest. The first four maxillary teeth are close together. Posterior to the fourth the teeth are all moderately spaced from each other, and all have separate alveoli, possibly excepting the thirteenth and fourteenth.

The NASALS, PREFRONTALS, and LACHRYMALS are not sufficiently well preserved to warrant detailed description, except that the lachrymals were apparently large.

The FRONTAL is not especially distinctive, except that the inter-orbital plate is of moderate width and is concave upward, and that the bone is apparently excluded from the borders of the supratemporal fenestrae.

The PARIETAL is extended backward into a prominent process, excluding the supraoccipital from the superior surface of the skull.

The SQUAMOSALS also are extended backward at the postero-external corners of the cranial table.

The PALATINES, PTERYGOID, AND BASISPHENOID are not preserved.

The occipital condyle of the BASIOCCIPITAL is bent sharply downward.

The POSTORBITAL, ECTOPTERYGOID, SUPRAOCCIPITAL, EXOCCIPITALS, JUGALS, QUADRATOJUGALS, AND QUADRATES are not distinctive.

## LOWER JAWS

The lower jaws are better preserved than the skull, being essentially complete.

The jaws are narrow at the tip; their external borders diverge rapidly to the level of the fourth teeth. From this point backward the divergence of the two rami is slight when considered in connection with the broad, short skull. The amount of anterior and lateral overhang of the upper jaws over the lower is considerable.

The symphysis is short, extending back only to the level of the posterior borders of the fourth teeth. The degree of participation of the splenial in the symphysis is not clear, but evidently it was slight. The external mandibular foramen is slight, its length being only about one-tenth of the total length of the skull. The axis of maximum length of the fenestra is oblique to the long axis of the ramus, bending downward slightly in the anterior direction.

The vertical festooning of the superior border of each ramus is considerable, but not excessive; there are pronounced elevations at the levels of the first, third, and fourth, and tenth and eleventh teeth, with valleys between them.

The first tooth is preserved on the left side; it is large and prominent. The two first teeth are rather widely separated at the median line. The second alveoli indicate much smaller second teeth; they are spaced rather far from the first. The third alveoli are very small, being about the smallest in the dental series. They are widely spaced from the second alveoli, and are very close to the large fourth alveoli, being located on the same buttresses as the latter. The fourth alveoli are by far the largest in the series. They are situated on prominent buttress-like elevations, along with the third and fifth. They are located very close to the small third and fifth alveoli. Back of the fourth are four small alveoli, spaced moderately far apart from each other (the first of these, being the fifth in the series, is close to the large fourth, as noted above). Posterior to each eighth alveolus is a broad space, which is succeeded by three teeth close together, the ninth, tenth, and eleventh. Of these the ninth and eleventh are of moderate size, while the tenth is large, being only slightly smaller than the first. Posterior to the eleventh are four moderate-sized alveoli that are moderately spaced from each other.

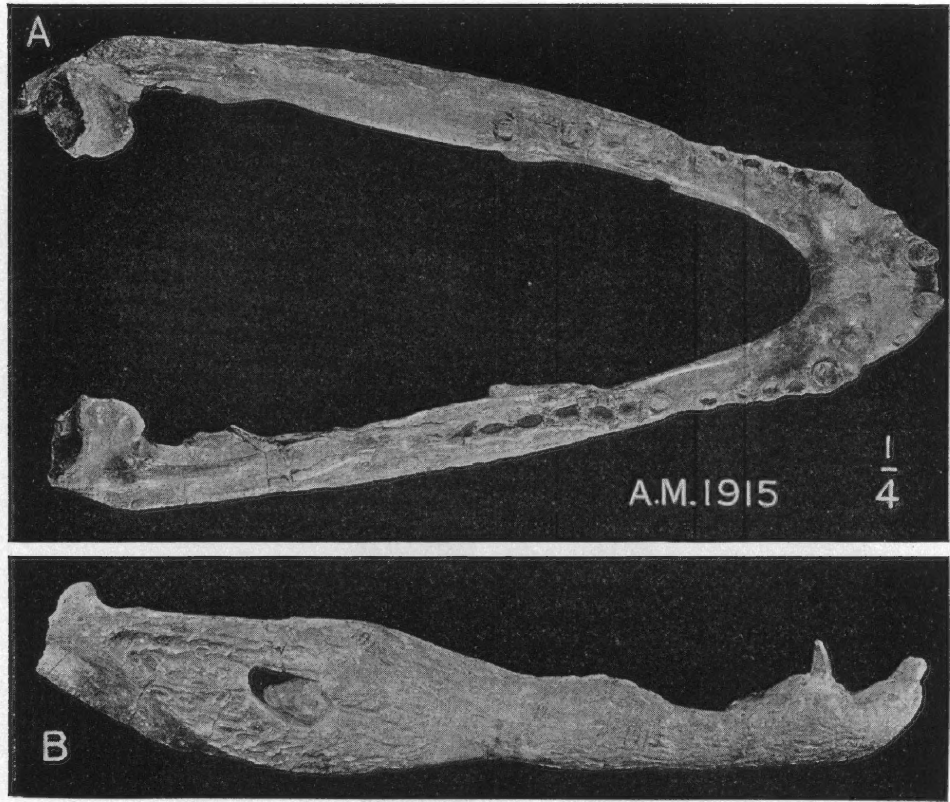


Fig. 5. *Crocodilus sivalensis* Lydekker. Jaws. Amer. Mus. No. 1915. About one-fourth natural size. A. Superior view. B. Lateral view, right side.

MEASUREMENTS

	mm.
Length of skull, occipital condyle to tips of snout.....	403
Length of skull, from tips of quadrate to tip of snout.....	426
Breadth of skull across quadratojugals.....	224 est.
Breadth of skull at anterior ends of orbits.....	197½
Breadth of skull at fifth maxillary teeth.....	173
Breadth of skull at premaxillo-maxillary notches.....	110
Breadth of premaxillaries, maximum.....	119
Breadth of cranial table, posterior end.....	127 est.
Breadth of interorbital plate.....	16
Breadth of interfenestral plate of parietal.....	42
Length of supratemporal fenestrae.....	33
Breadth of supratemporal fenestrae.....	26
Length of external narial aperture.....	57 est.
Breadth of external narial aperture.....	72
Mid-line suture on palate between the two maxillaries.....	78

MEASUREMENTS (*Continued*)

	mm.
Length of mandible, median.....	440
Breadth of mandible, maximum.....	224
Breadth of mandible across the fourth teeth.....	106
Length of symphysis.....	64

## CONCLUSIONS

The characters listed above agree rather closely with those of the "mugger" (*Crocodilus palustris* Lesson), and the specimen supports Lydekker's view that *C. sivalensis* is closely related, if not directly ancestral, to *C. palustris*.